Food Preference and Ovarian Development of the Melon Fly, Dacus cucurbitae Coquillett, as Influenced By Diet*

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During the past years, observations and studies have been made on the food preference and reproduction of various species of tephritid fruit flies. However, the relationship of food preference and rate of ovarian development is inadequately known. The present study is concerned with these two aspects of fruit fly biology.

Much of our current information on food preferences of fruit flies is based on field observations. Back and Pemberton (1917) reported that the melon fly, *Dacus cucurbitae* Coquillett, was attracted to honeydew. Other species observed feeding on honeydew are *Dacus oleae* (Silvestri, 1914), *Epochra canadensis* (Severin, 1917), *Rhagoletis completa* (Boyce, 1934) and *Dacus diversus* (Batra, 1954).

Though studies on the effect of nutrition on ovarian development have been made by various workers, these were concerned largely with fertility and fecundity. One of the early workers was Marlowe (1945) who studied the effect of various foods on the ovarian development of the melon fly. He found that when the adults were fed sugar and molasses for 30 days no ovarian development occurred. Partial to complete development was obtained with diets containing fruits such as cucumber, papaya, tomato, and orange. The marked increase in fecundity and fertility of *D. cucurbitae*, *D. dorsalis* Hendel, and *Ceratitis capitata* Wiedemann when fed protein supplements was noted subsequently by Hagen and Finney (1950). Kamal (1954), conducting ecological and nutritional studies on the cherry fruit fly, *Rhagoletis cingulata* (Loew), concluded that diets containing yeast increased fecundity. Hagen (1956) observed that when honeydew, excreted by the citrus mealy bug, *Planococcus citri* (Risso), was fed to the adults of *D. dorsalis* the fecundity and fertility were comparable to those induced by a fructose plus a yeast hydrolysate diet. In addition, Hagen noticed that the Mexican fruit fly, *Anastrepha ludens* (Loew), deposited eggs when fed on a honeydew diet while no eggs were deposited when fed on a carbohydrate diet.

It is evident from the literature that workers in the past were concerned chiefly with the end effects of nutrition which were measured in terms of fecundity and fertility. One of the objectives of this study was to determine the growth of the reproductive system as influenced by diet. Growth, in the present study, was determined by measuring the size of the ovaries and oviducts.

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Materials and Methods

Feeding Preference: In testing the food preference of the melon flies, two rectangular cages about 28 × 17 × 21 inches, each containing approximately 150 flies, were used. Four series of nutrients were tested: (1) honeydew; (2) yeast hydrolysate; (3) sucrose; and (4) sugar-cane stalks. Honeydew was obtained from the sugar-cane mealy bug, *Saccharicoccus sacchari* (Cockerell). The mealy bugs were reared on sugar-cane stalks cut approximately 9 to 10 inches long and planted in vermiculite. The yeast hydrolysate[1] and sucrose (commercial cane sugar cubes) were exposed to the flies by placing them on the cut top ends of the sugar-cane stalks free of mealy bugs. Cut cane stalks were used in every series as a control.

The nutrients were placed in the cages in a 4 × 3 randomized block design. Observations were made at hourly intervals and the number of flies feeding on each of the respective series of nutrients counted.

In each cage, water was supplied at all times in 100 ml. beakers partly filled with water with a wax float to prevent the flies from drowning.

Hydro-thermograph records were kept during the experiment. The temperature ranged from 78° F. to 92° F. and the relative humidity from 46 to 82 percent.

Ovarian Development: To observe the effect of nutrition on ovarian development, flies were kept in cubical screen cages measuring about 10 inches on each side and were fed three different series of diets. Series I contained water and sucrose; series II, water, sucrose, and yeast hydrolysate; and series III, water and honeydew. Water was supplied either on moist cotton in Syracuse dishes or in 100 ml. beakers with a wax float. Sucrose was supplied in the form of commercial cane sugar cubes. Honeydew was obtained from the sugar-cane mealy bug as described above. During the tests, the terminal portion of the cane bearing the mealy bugs was inserted in the cages, thus exposing the mealy bugs to the melon flies. The cane stalks were changed daily to insure a supply of honeydew.

The adults used in each series were newly emerged individuals which had not yet fed. In series I and II, there were two cages, each containing approximately 50 males and 50 females. In series III, there were six cages, each containing 3 males and 3 females. These small numbers were used because of the limited amount of honeydew excreted by the mealy bugs.

To determine the growth rate of the ovaries two females, one from each replicate cage, were dissected daily. The genital organs were then mounted in water on microscope slides. Using an ocular micrometer, the lengths of the ovaries and lateral oviducts were measured. All measurements were taken immediately after mounting.

The temperature during the experiments ranged from 76° F. to 92° F. and the humidity, from 48 to 90 percent.

[1] Marvin R. Thompson Co., Stamford, Connecticut.

TABLE 1. The Mean Number of Melon Flies Observed Feeding on Various Diets.

Diet	Experiment 1				Experiment 2				Experiment 3				Experiment 4				Experiment 5			
	Test A		Test B		Test A		Test B		Test A		Test B		Test A		Test B		Test A		Test B	
	Mean No. of Flies	$\sqrt{x+1}$	Mean No. of Flies	$\sqrt{x+1}$	Mean No. of Flies	$\sqrt{x+1}$	Mean No. of Flies	$\sqrt{x+1}$	Mean No. of Flies	$\sqrt{x+1}$	Mean No. of Flies	$\sqrt{x+1}$	Mean No. of Flies	$\sqrt{x+1}$	Mean No. of Flies	$\sqrt{x+1}$	Mean No. of Flies	$\sqrt{x+1}$	Mean No. of Flies	$\sqrt{x+1}$
Honeydew	6.7	2.68	0.3	1.14	1.0	1.38	0.6	1.24	4.3	2.27	2.7	1.86	2.0	1.71	2.0	1.71	7.7	2.91	3.7	2.05
Yeast hydrolysate	59.7	7.78	22.3	4.69	34.7	5.87	12.7	3.67	13.7	3.73	7.0	2.81	7.3	2.89	2.0	1.71	—	—	—	—
Sucrose	37.7	6.21	21.0	4.59	88.0	9.32	35.3	6.00	41.0	6.40	24.3	5.03	26.7	5.17	12.7	3.65	46.3	6.79	31.7	5.59
Sugar cane stalk	1.3	1.51	0.0	1.00	0.0	1.00	0.0	1.00	0.0	1.00	0.0	1.00	0.0	1.00	0.0	1.00	0.0	1.00	0.0	1.00
Differences required for significance	1%	2.06		2.51		4.78		1.28		3.29		0.98		2.40		1.66		2.04		4.63
	5%	1.36		1.66		3.15		0.85		2.17		0.65		1.59		1.09		1.91		2.79

Results

Feeding Preference: The results obtained from five experiments conducted on the feeding preference of melon flies are presented in Table 1. Yeast hydrolysate was superior to sucrose only in experiment 1A. In all other experiments, sugar was more attractive than yeast hydrolysate. Table 1 also indicates that honeydew was less attractive than sugar in all experiments. It was also less attractive than yeast hydrolysate in all experiments except experiment 4, in which there was no significant difference between honeydew and yeast hydrolysate. Experiment 5 was conducted to compare the attractiveness of honeydew, sucrose and sugarcane stalk in the absence of yeast hydrolysate. As shown in Table 1, sucrose was more attractive than either honeydew or cane stalk.

Ovarian Development: The results on the effect of diet on ovarian development show that the growth rate of ovaries of flies fed on a diet consisting of yeast hydrolysate, sucrose, and water was greater than that of the flies fed on diets containing either water and sucrose, or honeydew (fig. 1). The growth rate of the ovaries of flies fed on yeast hydrolysate was essentially the same during the first four days; however, after the fourth day, there was a remarkable increase in growth. The diameter of the ovaries increased more than 3½ times between the fourth and sixth days. Periodic dissection showed that fully developed eggs were first noted in flies 6 to 8 days old (fig. 3). It was of interest to note that the period of slow growth and the period of increased growth corresponded to the preoviposition and oviposition periods, respectively. The low value obtained at 7 days (fig. 1) may be due to the lack of fertilization; however, the effect of lack of fertilization on the growth rate of the ovaries was not investigated.

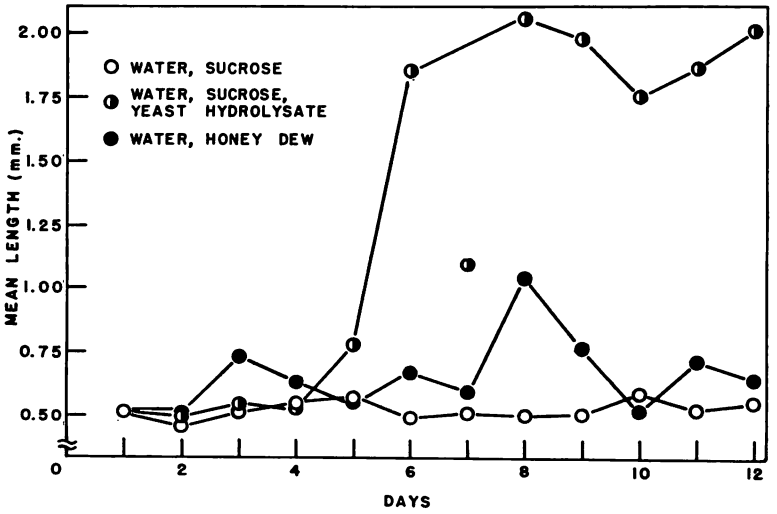

FIG. 1. The effect of various diets on the growth rate of the ovaries of the melon fly, *Dacus cucurbitae* Coquillett.

Although the ovaries of flies fed sucrose and water, and honeydew and water failed to completely develop during the experimental period, differences in the size of the ovaries were noted. The ovaries of flies that were fed sucrose and water did not show any signs of development during a period of 12 days (figs, 1, 3). However, the ovaries of flies fed on honeydew and water were slightly larger than those fed on sucrose and water, indicating that honeydew contained nutrients that promoted ovarian development. The erratic results obtained with honeydew are probably due to the differences in the amount of honeydew produced by different groups of mealy bugs that were placed in the cages daily. Furthermore, honeydew production may vary from day to day.

The data (fig. 2) show the measurements taken on the lateral oviducts of flies fed on the three series of diets. It may be noted that there was a decreasing trend in the length of the lateral oviducts of flies that were fed yeast hydrolysate.

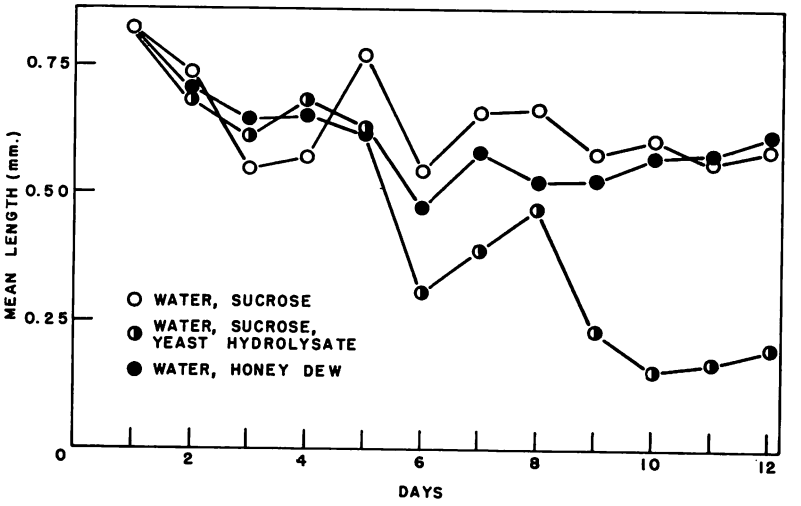

FIG. 2. The effect of various diets on the length of the lateral oviducts of the melon fly, *Dacus cucurbitae* Coquillett.

This trend, though not very marked, is also evident among flies that were fed honeydew. This shortening of the lateral oviducts was evidently related to the increased size of the ovaries. The ovaries, instead of expanding in the direction distal to the lateral oviducts, expanded inward toward the fork of the common oviduct, resulting in the shortening of the lateral oviducts. For this reason, the lateral oviducts of gravid flies are so short that they are hardly visible.

DISCUSSION

The results of this study show that honeydew is not as attractive to the adults of the melon fly as yeast hydrolysate or sucrose even though it is known to

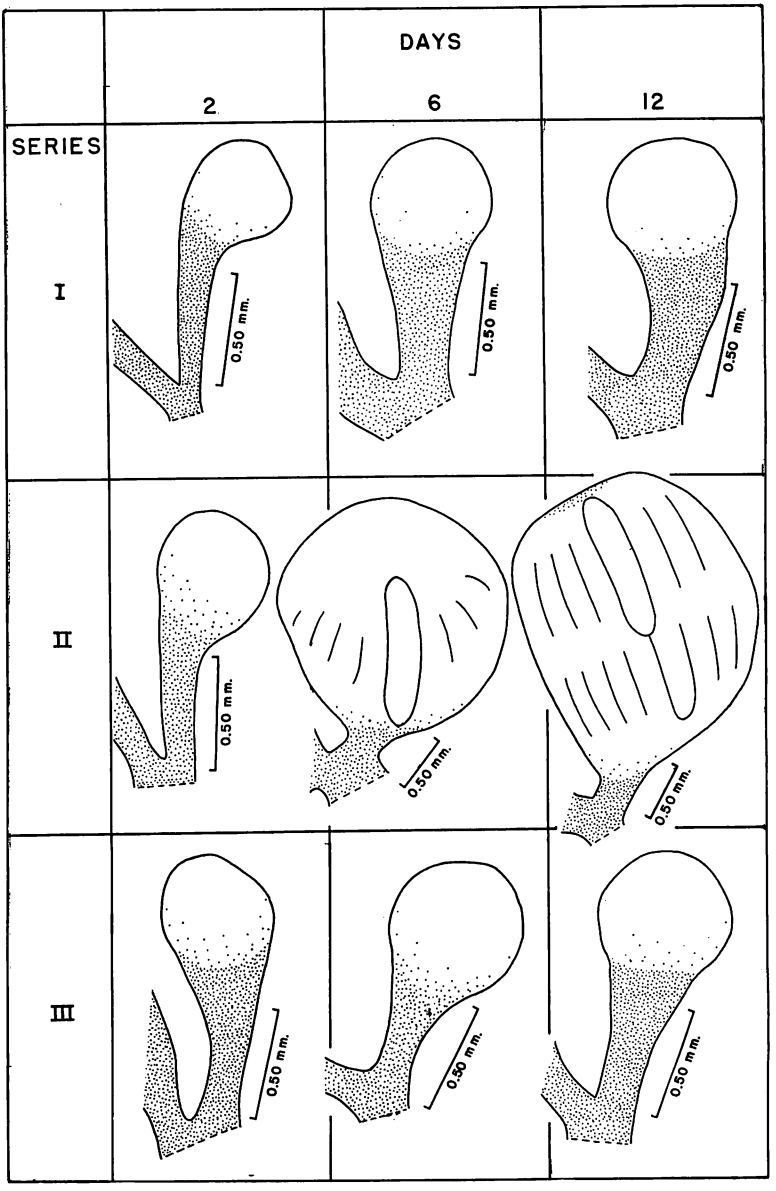

FIG. 3. The ovaries and lateral oviducts of the melon fly, *Dacus cucurbitae* Coquillett, fed on various diets: series I, water and sucrose; series II, water, sucrose, and yeast hydrolysate; series II, water and honeydew.

contain carbohydrates and amino acids (Gray, 1952, Ewart and Metcalf, 1956). Furthermore, under field conditions honeydew has been reported to be attractive to the adults of melon fly as well as other species of tephritid fruit flies. The failure of honeydew to attract flies to a greater extent than either sugar or yeast hydrolysate in this study is difficult to explain on the basis of available data.

There appears to be little or no relationship between attractiveness and nutritive value as measured by the rate of ovarian development. For example, sugar was highly attractive but had little effect on the ovaries. On the other hand, honeydew was not attractive, but its effect on ovarian development was greater than that of sucrose.

In experiment 1, yeast hydrolysate was more attractive than sucrose. However, in all other experiments, sugar was superior to yeast hydrolysate. In experiment 1, the flies were starved for approximately 16 hours while those in the other experiments were starved for 40 hours. Although one is tempted to conclude that starvation influenced the choice of food, such conclusions must be deferred until further experiments are carried out.

It is evident from the results of this study that the growth rate of ovaries was highest among flies fed on a diet containing water, sucrose, and yeast hydrolysate. This result is in general agreement with that of Hagen and Finney (1950) who reported that fecundity and fertility were increased by use of this yeast hydrolysate diet. Thus, in addition to increasing fecundity and fertility, this proteinaceous diet increases the actual growth rate of the ovaries and oviducts.

There was no growth of either the ovaries or oviducts of flies fed on a diet of sucrose and water even though sucrose was attractive to the adult flies. Marlowe (1945) and Hagen (1956) also found that flies fed on sucrose failed to lay eggs.

In regards to honeydew, Hagen (1956) found that the fertility and fecundity of *D. dorsalis* and *A. ludens* were increased by the use of the honeydew of *P. citri*. The present study showed that the ovaries and oviducts of flies fed on the honeydew of *S. sacchari* developed at a very slow rate. This retarded growth may be due to differences in the composition of the honeydews for it has been pointed out by various workers that honeydew composition may vary with such factors as differences in the excreting species and kind of host plant. Although efforts were made to supply adequate quantity of honeydew, it is possible that the total amount available per fly was perhaps not sufficient. Failure of the honeydew to attract the flies might also be a factor.

The beneficial effects of protein diets on ovarian growth rate and fecundity of tephritid fruit flies appear to be clearly established. In the light of these findings, it is of interest to comment on the results obtained by Marlowe (1945). He found that melon-fly adults when fed cut fruits, such as tomatoes, oranges, and cucumbers, showed partial to complete ovarian development. It is extremely doubtful that the fruits *per se* contained sufficient amino acids and other essential constituents necessary for ovarian development. The ingestion of microorganisms,

especially yeasts, from the fermenting fruits could have supplied the necessary nutrients.

Summary

A series of five experiments was conducted to determine the food preferences of the melon fly adults. The order of decreasing attractiveness was sucrose, yeast hydrolysate, honeydew, and cut cane stalks, respectively.

Three different series of diets containing various nutrients were tested to observe their effects on the rate of ovarian development. The rate of development was greatest when melon fly adults were fed on a diet consisting of water, sucrose, and yeast hydrolysate. The size of the ovaries of flies fed sucrose remained the same throughout the 12-day observational period. There was ovarian development among flies fed honeydew, but the growth rate was considerably less than that of flies fed yeast hydrolysate. It was found that with the increased ovarian development, there was a corresponding decrease in the lengths of the lateral oviducts.

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